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ABSTRACT

This study was designed to identify teaching-learning process behaviors that affect pupil achievement on a psychomotor task. Forty preservice physical education teachers each taught a twenty-minute cartwheel lesson to three elementary school pupils. Students' cartwheels were filmed before and after the instructional sessions, and analyzed for body control. The videotaped instructional sessions were analyzed using a teacher behavior observation system. Factor analysis of the raw data led to the formation of four teacher behavior factors. Group instruction of specific information and feedback to a single student on the entire motion were positively related to pupil achievement, while simultaneous practice with the teacher talking and detailed verbal feedback were negatively related to pupil achievement. Eighty percent of variation was explained by learners' readiness for instruction. It was concluded that the appropriateness of teacher behaviors depended not only on the expected learning outcomes, but also on the readiness of the learners to benefit from specific teacher-learner interactions. (Author/FG)

Teaching-Learning Process Factors Related to Pupil Achievement on a Psychomotor Task

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Running Head: Process factors related to achievement

Abstract

The study was designed to identify teaching-learning process behaviors that effect pupil achievement on a psychomotor task. Forty pre-service physical education teachers each taught a 20-minute cartwheel lesson to 3 randomly assigned elementary pupils. Students were pre- and posttested on the cartwheel with filmed performances analyzed for body control in both vertical and horizontal planes. The videotaped instructional sessions were analyzed using a teacher behavior observation system. Factor analysis of the raw data led to formation of four teacher behavior factors. Of these factors, two were positively related to achievement while two factors were negatively related to pupil avhievement on the cartwheel. The number of cartwheels performed was also used as a process factor. Multiple regression was used to determine the relationship of pretest and process factors to posttest scores and to identify a set of variables that explained variation in achievement. Eighty percent of variation was explained by pupil entry behavior and four of the process factors with 75% explained by entry behavior alone. The strongest process factor was negatively related to achievement and the number of cartwheels performed was postively related to entry skill level as well as final performance. Teacher behaviors in and of themselves may be appropriate or inappropriate depending not only on the expected learning outcomes, but also on the readiness of the learners to benefit from specific teacher-learner interactions.

Teaching-Learning Process Factors Related to Pupil Achievement on a Psychomotor Task

Using the knowledge base gained from motor learning and descriptive-analytic research, application should follow. However, there is a gap -- actually the gap is a chasm -- but some valiant pedagogues are trying to build bridges to improve the learners' lot. One research approach which provides input is to study how the teacher behaves and relate that to what pupils learn. The teacher-learner interaction (the *process* of teaching) is compared to student learning (the *product* of teaching) in a form called the process-product paradigm, one format in teacher effectiveness research (Cooley, et al., 1977). Few studies in physical education have used this approach due to a number of complex factors including almost prohibitive costs for an unfunded research effort (Locke, 1979). One such study completed by Yerg in 1977 provided non-definitive results in terms of proposed research hypotheses (that teacher behavior would account for statistically significant portions of variance in achievement), but knowledge gained on the use of the paradigm in physical education warrants further study. That further study was possible as the data were preserved on film and videotape and will subsequently be described as the instructional data bank. The purpose of this study was to examine the relationship of selected process variables to pupil achievement on a cartwheel task.

Instructional Data Bank

Data bank contents. The instructional data bank contains 40 20-minute instructional sessions on the cartwheel. The teachers were 40 pre-service physical education teachers. The learners were 120 pupils from grades three through six, randomly assigned to groups of three, who were filmed on pretest and posttest of the cartwheel with only the instructional session intervening.

Pupil performance tests. Since pupil final performance following instruction was the criterion of effectiveness, the measure of that performance is of interest. The task was the cartwheel, to be performed with both hands and feet landing in or as close to the designated target lane as possible. Multiple parallel lanes permit the measurement of deviations from the target lane as well as landing in the target lane. Scoring the filmed performance in the vertical plane was accomplished by using an overlay on the projected images that corresponded to the parallel line configuration on the horizontal. The cartwheel performances were measured in both the horizontal and vertical planes to reflect body control. In later childhood learners should be developing increased body control in their motor performances as they refine their movements.

Teacher behavior observation system. In addition to the pretest and posttest scores, an analysis of the videotaped instructional sessions was made using a specially designed teacher behavior observation system. The

system was designed to be consistent with the theoretical framework of the study. In other words, to identify teacher behaviors thought to facilitate pupil achievement on this task, the system provided data on the frequency, nature, and duration of specified teacher behaviors during instruction. At the first level teacher behavior was classified in one of three generic categories: task presentation, providing opportunity for practice, or providing feedback plus the category *other* for all interaction not included in the specified three. The second level of the system described the generic teacher behavior with regard to mode of communication, target audience, time of delivery, intent (motivational or instructional) of behavior, and level of detail of the behavior. The twenty-minute instructional session was time-sampled. Five seconds, that is, the 15th to 20th second of each 20-second interval timed by a stopwatch, of each 20 seconds were observed and categorized yielding 60 samples of teacher behavior for every instructional session. As this paper is not intended to detail a teacher observation system nor the protocols of the 1977 study, further detail will be omitted. (For additional information, consult Yerg, 1977.)

Procedures

Subjects were 40 pre-service physical education teachers each conducting a 20-minute instructional session on the cartwheel to three randomly assigned elementary school pupils from grades three through six. Using the teacher behavior observation system and corresponding tally sheet,

frequency data were obtained on teacher behaviors occurring during instruction. Individual cartwheel performance tests were administered immediately preceding and following the instructional session. These data were obtained from the previously described instructional data bank.

Analysis and Results

From the system data, frequencies of teacher behavior in each cell were determined. Zero order correlations and stepwise multiple regression analyses of these raw data were examined. Positive and negative impact on achievement was noted from these early analyses. Factor analysis provided data on related clusters within the raw data and resulted in the formation of four composite factors. Of these factors, the elements of two, task presentation characterized by group instruction of specific information (TSKP) and feedback to a single student with reference to the total move (FDBK1), were positively related to pupil achievement on the cartwheel. The other two factors, practice opportunity in which teacher talk giving information occurred (PRCT) and feedback characterized by verbal, detailed information (FDBK2), were negatively related to pupil achievement. In addition to these teacher behavior factors, the actual number of cartwheels performed by learners during the instructional sessions was determined. It should be noted that there was a significant difference, t (118) = 8.56, $p < .001$, between pretest and posttest scores indicating that improvement in cartwheel performance occurred over the 20-minute lesson.

Multiple regression analysis may be used to explain variation in a dependent variable as a function of a given set of independent variables plus unexplained variation. The dependent variable (or criterion of effectiveness) in this study was the group mean on the cartwheel posttest. To control for pupil entry behavior, pretest scores were entered as an independent variable. The other independent variables were the four teacher behavior factors previously described, namely, task presentation, feedback one, providing for practice, and feedback two, plus the number of cartwheels that learners actually performed during the instructional session. Forward stepwise regression analysis was conducted to determine order of entry as well as total effect of these independent variables on learner achievement.

A regression equation is a statement of the dependent variable as a function of the independent variable(s) plus error. The restricted model regression equation was a statement of the final performance as a function of initial performance plus error. The full model was a statement of the final performance as a function of initial performance, the four teaching process factors, and the number of cartwheels performed by learners during instruction. The use of the simultaneous restricted and full regression equations, as presented in Table 1, served two main purposes. First, it

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INSERT TABLE 1 ABOUT HERE

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permitted the examination of residuals in the restricted model to determine appropriateness of the linear measures and allowed examination of the effect of entry behavior on achievement. The second use of the two equations was to isolate the process effects by comparing the coefficients of multiple determination.

Stepwise regression was used to determine the order of entry, the relative importance, of each of the factors in explaining variation in final performance scores. The summary table and order of entry are detailed in Table 2. As expected, the pretest scores, indicative of what the learner brings to the learning environment, were the first factor. The teacher

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INSERT TABLE 2 ABOUT HERE

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behavior factor most strongly contributing to explanation of variation was a feedback composite in which the teacher talked to learners and gave specific information, that is, detailed information, about their performance. This factor was *negatively* related to pupil achievement. The second factor was also a feedback factor, one in which the teacher talked with a single student giving information about the performance of a more general nature. This factor was positively related as was the subsequent entry of actual number of cartwheels performed. Task presentation to the group with specific information was positively related, followed by practice opportunity during which the teacher gave information about performance. This final

entry was negatively related to pupil final performance. The first four process variables contributed to reducing variation with the fifth variable accounting for a very slight reduction and thus was eliminated from further analyses.

Table 3 is the full model regression summary table from the 1977 Yerg study presented for comparison purposes. Note the coefficient of

INSERT TABLE 3 ABOUT HERE

determination (R^2) of .77. That is the amount of variation (77%) in the final performance explained by the set of factors used in that study. Referring to the present study (Table 2), the R^2 of .80 indicated that a greater portion of the variation in final performance was explained thus reducing unexplained variation and providing a better fit of the model with the set of factors selected for inclusion in this study. Note also regarding the variables in the equation, that pupil initial performance, the two feedback variables, and number of cartwheels are statistically significant at designated levels with one feedback variable being negative and the other positive.

The isolation of process effects is accomplished by the comparison of the coefficients of determination from the full and restricted models. This permits the examination of the effect of the independent variables after controlling for pupil entry behavior. The regression summary table for the

restricted model which was the same for both studies is presented in Table 4.

INSERT TABLE 4 ABOUT HERE

The coefficient of determination (R^2) is .75 indicating that 75% of the variation in final performance was explained by learners' initial performance. The comparison of the isolation of teacher effects (Yerg, 1977) and process factors (present study) are presented in Table 5. The 1977 study resulted in teacher effects of 2% with a calculated, non-significant F (4,34) = 0.696 while the present study had an F (4,34) = 2.013 on 5% process effects. This

INSERT TABLE 5 ABOUT HERE

comparison indicated that a better fit of the regression model was obtained in the latter study even though statistical significance was not reached.

Discussion

A number of important points were raised by this study, particularly in comparison to the earlier Yerg study. Initially, the posit for the earlier study was to build the teacher behavior composites and thus the regression model on teacher behaviors thought to positively effect (to facilitate) achievement on the cartwheel task. This was also based on assumptions of entry characteristics of a group of learners which turned out to be in error. Further, only positive teacher behaviors were considered and from the later study it was evident that inappropriate teacher behaviors are important

factors in studying teacher effectiveness. The adjustment in selection of teacher behavior process variables and the addition of actual practice trials rather that sampled practice indicators raised the effect of the independent process variables from two to five percent over the period of a twenty-minute lesson. With cognitive domain studies reporting room for four to nine percent available for teacher effects over the school year (McDonald, 1976), the improvement of fit in this study seemed encouraging. Additional research will aid in clarifying further the use of this paradigm in physical education. Cooley et al. (1977) explained that early studies are often imperfect and require refinement before all elements of a teacher effectiveness study can be fully realized and implemented.

The impact of feedback as both positive and negative factors in achievement warranted discussion. Feedback, to be useful in promoting achievement, must be appropriate to the learners, the context, and the task. In this study, learners were novices to the task and therefore the individualized feedback of a general nature was beneficial to learners while the specific, detailed feedback seemed to inhibit achievement. Perhaps that was because learners were not ready nor able to utilize the teacher input and therefore it detracted from use of practice time. The ability of learners to profit from feedback cannot be generalized; it must be specific to the teaching-learning transaction and context.

The results of limited study cannot be generalized, however, the

preservation of data for re-analysis has provided opportunities to clarify original research processes and by that method the research has been refined. Process-product research in physical education has a long way to go -- with a multitude of tasks and a diversity of learner populations to consider. This study does underscore, however, that one of the critical factors to be considered in determining effective teacher behaviors is comprehension of the context in which they occur. That is, teacher behaviors in and of themselves may be appropriate or inappropriate depending not only on the expected learning outcomes, but also on the readiness of the learners to benefit from specific teacher-learner interactions.

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Table 1

Simultaneous Regression Equations for Restricted and Full Models

Restricted model:

$$F_i = b_0 + b_1 I_i + e_i$$

Full model:

$$F_i = b_0 + b_1 I_i + b_2 X_1 + b_3 X_2 + b_4 X_3 + b_5 X_4 + b_6 X_5 + e_i$$

where,

F_i = Final pupil performance score

I_i = Initial pupil performance score

X_1 = Factor - task presentation

X_2 = Factor - feedback one

X_3 = Factor - providing for practice

X_4 = Factor - feedback two

X_5 = Number of cartwheels actually performed

b = Regression weight

e_i = Residual

Table 2

Multiple Regression Data for Full Model

Multiple R = 0.90			R^2 = 0.80	
Source of Variance	df	Sum of Squares	Mean Square	F
Regression	5	1065.39	321.08	26.97***
Residual	34	404.71	11.90	
Variables in the equation		B	S.E. of B	F
Pupil initial performance		.656	.080	67.00***
Feedback two		-.427	.167	6.54**
Feedback one		.594	.254	5.07**
Cartwheels performed		.028	.014	3.81*
Task presentation		.161	.124	1.69
(Constant)		17.720	3.691	23.05***

*p < .06

**p < .05

***p < .001

Table 3

Multiple Regression Data for Full Model[a]

Multiple R = 0.877			R^2 = 0.77	
Source of variance	df	Sum of Squares	Mean Square	F
Regression	5	1547.46	309.50	22.74*
Residual	34	462.65	13.61	
Variables in the equation		B	S.E. of B	F
Pupil initial performance		.774	.08	91.95*
Providing for practice		.114	.20	0.37
Teacher mastery of content		.488	.48	1.04
Providing feedback		-.114	.13	0.70
Task presentation		-.137	.35	0.16
(Constant)		15.930		

[a]Summary table from 1977 Yerg study.

*p < .001

Table 4

Multiple Regression Data for Restricted Model

Multiple R = 0.867			R^2 = 0.751	
Source of variance	df	Sum of Squares	Mean Square	F
Regression	1	1509.56	1509.56	114.60*
Residual	38	500.55	13.17	

*p < .001

Table 5

Comparison of Coefficients of Determination

Present study	
	$R_F^2 - R_R^2 = .80 - .75 = .05$
	calculated $F = 2.013$ [a]
Yerg, 1977	
	$R_F^2 - R_R^2 = .77 - .75 = .02$
	calculated $F = 0.658$ [a]

[a] $_{.05}F_{4,34} = 2.658$